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Distribution of *Diachea* (*Didymiaceae, Myxomycetes*) in the northeastern region of Brazil

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Abstract —In an effort to expand knowledge of the distribution of Neotropical myxobiota, the authors summarize the occurrence of *Diachea bulbillosa*, *D. leucopodia*, and *D. silvaepluvialis* in northeast Brazil based on their own collections made between 1995 and 2008, analysis of additional Brazilian herbarium specimens, and comprehensive bibliographical research. Colonized substrates identified were bark of living trees (corticolous), litter (foliicolous), and dead wood (lignicolous), with the largest populations of the predominant foliicolous specimens found in the Atlantic forest. A map showing the geographical distribution in Northeast Brazil accompanies species descriptions, taxonomic observations, and known distribution for each species. This constitutes first reports for *D. leucopodia* from Rio Grande do Norte state and *D. silvaepluvialis* from Paraíba and Pernambuco states.

Key words — floristic survey, taxonomy, chorology

Introduction

Diachea Fr. has been subject to taxonomic disagreement since the late 19th century, with the genus first assigned to *Trichiacei* (Fries 1825; Martin & Alexopoulos 1969). Gaither & Keller (2004) remark on subsequent transfers to the *Stemonitales* (based on the iridescent peridium and noncalcareous capillitium) or the *Physarales* (emphasizing the calcareous stalk and columella). Based on the biochemical study of melanin extracted from spores of *D. leucopodia*, Kalyanasundaram & Mubarak Ali (1989) concluded that *Diachea* may be regarded as a link that indicates a phylogenetic relationship between the *Physarales* and *Stemonitales*, opinion supported by recent phylogenetic studies

(Fiore-Donno et al. 2005). Within *Physarales*, some authors, such as Lister (1925), Hagelstein (1944), Farr (1974) and Martin et al. (1983), shuffled the genus between *Physaraceae* and *Didymiaceae*. Martin et al. (1983), following Farr (1974), placed *Diachea* in the *Didymiaceae* (*Myxogastromycetidae*) based on plasmodium type, limy stalk, columella and hypothallus, and a stalk structure indicating a subhypothallic method of sporophore development; this position is also adopted in this paper.

Diachea is not a species-rich genus and is currently represented by only 12 species (Lado 2001, Hernandez-Crespo & Lado 2005); this listing includes *D. arboricola*, recently described as a corticolous species with a very distinct type of spore ornamentation and known only from the tree canopy in the Great Smoky Mountains National Park, USA (Keller et al. 2004). It excludes *D. deviata* Nann.-Bremek. & Y. Yamam., which Gaither & Keller (2004) consider an aberrant form of *D. subsessilis* Peck.

The first studies on the Brazilian myxomycete biota (Torrend 1915, 1916) report *D. leucopodia* from the state of Bahia (Northeast Region) and the southeast states of Rio de Janeiro, São Paulo, and Minas Gerais; in addition, this was the only *Diachea* species recorded for Brazil between 1915 and 1996 (Putzke 1996).

More recently, *D. silvaepluvialis* and *D. bulbillosa* were recorded for the first time from Brazil and *D. leucopodia* for the first time from the state of Piauí (Mobin & Cavalcanti 1999, Bezerra et al. 2008).

Considering that knowledge on Brazilian myxomycetes is still fragmented and lacking baseline data on the distribution ranges of several species, and based on the characteristics of specimens from different states, the descriptions of three *Diachea* species are presented, along with comments on their distribution in the northeastern region of Brazil.

Materials and methods

Northeastern Brazil comprises nine states and occupies an area approximately 1,548,672 km² (IBGE 1985). With an extensive coast, the region also borders the states of Pará, Tocantins, Distrito Federal, Minas Gerais, and Espírito Santo. Although approximately 788,064 km² of the territory lies in the Caatinga biome, there are many different ecological areas in the Northeast; Atlantic forest fragments and associated ecosystems of the Mata Atlântica biome are found in the coastal region of the states of Bahia, Sergipe, Alagoas, Pernambuco, Paraíba, and Rio Grande do Norte; savanna and savanna-like vegetation islands also occur, especially in the states of Piauí and Ceará (Sampaio 1995, Araujo et al. 1998, Lemos & Rodal 2002).

In addition to bibliographical research, UFP, URM, UFBA, HUEFS, IPA, and JPB herbaria were surveyed for the *Diachea* species that occur in each state of Northeast Brazil. This was complemented by field trips carried out by the authors between 1995

and 2008 in the states of Alagoas, Paraíba, Pernambuco, Rio Grande do Norte, and Sergipe.

The taxonomic classification of Martin et al. (1983) was adopted for genera and suprageneric categories, while Martin & Alexopoulos (1969) and Farr (1976) were used for species identification. Selected specimens were used to illustrate the sporocarps and taxonomically significant microstructures.

Localities and their geographic coordinates were determined from field notes and herbaria records and later employed to create a map of species distribution in the northeastern region.

Abbreviations used in the text include states: BA= Bahia; MG= Minas Gerais; PE= Pernambuco; PI= Piauí; PR= Paraná; RN= Rio Grande do Norte; RS = Rio Grande do Sul; SC= Santa Catarina; SP= São Paulo and herbaria: HUEFS = Universidade Estadual de Feira de Santana, Bahia; IPA = Empresa Pernambucana de Pesquisa Agropecuária, Recife, Pernambuco; JPB= Universidade Federal da Paraíba, João Pessoa, Paraíba; UFBA= Universidade Federal da Bahia, Salvador, Bahia; UFP= Universidade Federal de Pernambuco, Departamento de Botânica, Recife, Pernambuco; URM = Universidade Federal de Pernambuco, Departamento de Micologia, Recife, Pernambuco.

Taxonomy

Diachea Fr., Syst. Orb. Veg.: 143. 1825.

= *Diachaeella* Höhn., Akad. Wiss. Wien. Sitzungsber., Math.-Naturwiss 118: 436. 1909.

Sporangiate, stipitate or sessile, sporotheca globose or cylindric; peridium simple, thin, iridescent, tending to be persistent; columella, and stipe when present, calcareous, rigid, thick, tapering upward; capillitium limeless, of delicate threads united into a net, the tips attached to the peridium; spores black or dark purple in mass.

Spore pigmentation as well as capillitial pigmentation and mode of branching closely resembles that of the *Stemonitaceae* (Kalyanasundaram & Mubarak Ali 1989); according to Martin et al. (1983), limeless species point toward a possible close relationship between *Diachea* and *Comatricha* Preuss.

Key to *Diachea* species of the northeast region of Brazil

1. Stalk white or brownish; spore 7.5–11(–12.2) µm diam., violet-brown or light brown 2

1a. Stalk dark orange or dark brown; spore 10–14 µm diam., dark purplish-brown ..... *D. silvaepluvialis*

2. Sporotheca subglobose or obovate; capillitium a lax reticulum of purplish threads.....*D. bulbillosa*

2a. Sporotheca cylindrical or elliptical; capillitium consisting of dark reddish-brown, branched and anastomosed threads, pale at the tips ..... *D. leucopodia*

Species

Diachea bulbillosa (Berk. & Broome) Lister,
in Penzig, Myxomyc. Fl. Buitenzorg: 45. 1898. Figs. 1, 5
≡ *Didymium bulbillosum* Berk. & Broome, J. Linn. Soc., Bot. 14: 84. 1873.

Sporangia gregarious, stipitate, sporotheca subglobose or obovate, 335 – 430 µm diam., total height 1.2 mm; stalk 520 – 920 µm long, 335 – 350 µm at the base, 185 µm at the apex, calcareous, the lime aggregated into crystalline nodules with rhombohedron crystals; hypothallus inconspicuous; columella white, calcareous, capillitium lax, purplish threads united into a net, 1.5–3.0 µm diam.; spores dark in mass, violet-brown by transmitted light, globose to oval, with sparse and acute spines 1.5 µm long, 10(–12) µm in diam.

Distribution in Brazil: Northeast (PI).

Selected exsiccates: **Brazil. Piauí State**: PIRIPIRI, Sete Cidades National Park, Piscina do Bacuri, Mitra Mobin 30, 24.II.1995, on dead leaf (petiole) of *Mauritia flexuosa* L.f., UFP 16506; Piscina do Bacuri, Mitra Mobin 106, 24.III.1995, on dead leaf (petiole) of *Mauritia flexuosa*, UFP 16582; Piscina do Bacuri, Mitra Mobin 196, 27.V.1995, on dead leaf (petiole) of *Mauritia flexuosa*, UFP 16671.

Comments: Farr (1974) considers that if the structure of the lime is the sole character separating the genera *Didymium* (crystalline lime) and *Diderma* (granular lime), it would also be consistent to separate the granular-limed (temperate-zone material) and crystalline-limed (tropical or subtropical material) fruiting within *D. bulbillosa* at a species level. The Brazilian collections fit the species well, except for spores slightly larger than those found in temperate-zone specimens; they also have the typical rhombohedric crystals of tropical fruiting.

This is the second most common and widely distributed species of the genus (Farr 1974, Lado & Basanta 2008), but in Brazil it was found only at Piripiri County, Piauí State; all the specimens, collected in an area of secondary forest at the Sete Cidades National Park, were associated with *Arecaceae* (Mobin & Cavalcanti 1999).

Diachea leucopodia (Bull.) Rostaf., Sluzowce Monogr.: 190. 1874. Figs 2, 5
≡ *Trichia leucopodia* Bull., Hist. Champ. Fr. 1: 121. 1791.

Sporangia gregarious, stipitate, sporotheca cylindrical or elliptical, rarely globose, 410 µm diam. at the base and 260 µm diam. at the apex, total height 1 mm; hypothallus white, calcareous; stalk calcareous, white, 270 µm long, base 400 µm, apex 230 µm; peridium membranous, iridescent; columella cylindrical, calcareous, thick, white, reaching the top; capillitium dark reddish-brown, dense, with flexuous threads arising from all parts of the columella, 0.5–1.5 µm diam., paler at the tips; spores dark brown in mass, light brown by transmitted light, globose to oval, minutely roughened, 7.5–9 µm diam.

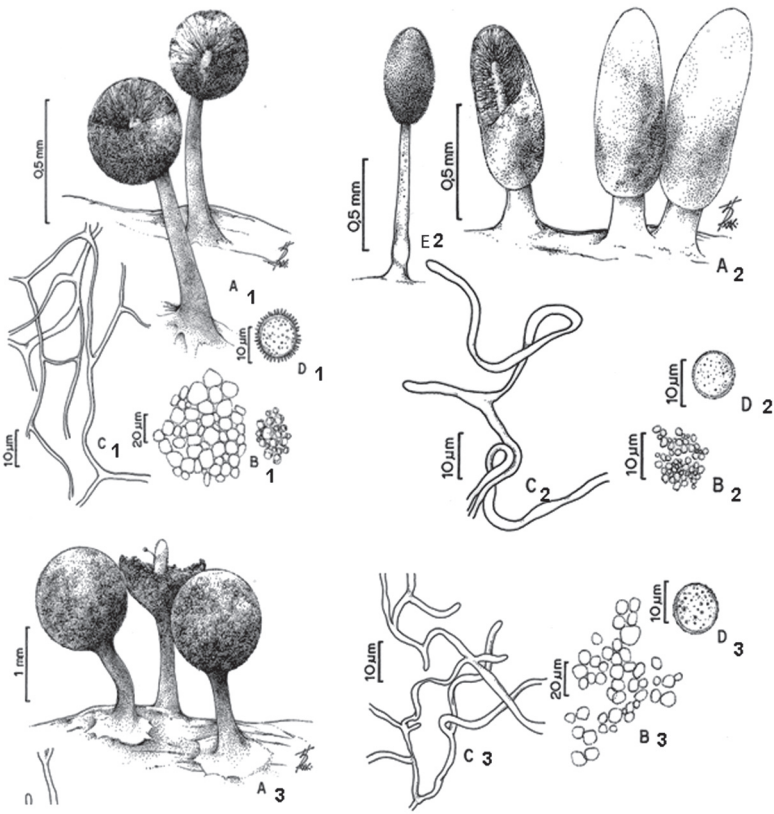
Distribution in Brazil: Northeast (BA, PE, PI), Southeast (MG, SP), and South (PR, SC, RS).

Selected exsiccates: **BRAZIL. Piauí State:** PIRIPIRI, Sete Cidades National Park, Lagoa Seca, Mitra Mobin 24, 22.II.1995, on dead leaf (leaflet) of *Copernicia prunifera* (Mill.) H.E. Moore (carnauba palm), UFP 16500; Lagoa Seca, Mitra Mobin 28, 22.II.1995, on dead leaf (leaflet) of *Copernicia prunifera*, UFP 16502. **Pernambuco State**: RECIFE, Dois Irmãos Forest, Nascimento, M. L, 11.VI.1976, UFP 2470; Pôrto, K. C. 5, 3.X.1980, on dead leaf, UFP5085; Correia, A. M. S., 28.XII.1981, UFP 5802; Espinheiro, Cavalcanti, L. H., UFP 2983; OLINDA, Chico Science Mangrove, Bezerra, A.C.C. 1, 17.XII.1998, bark of living *Laguncularia racemosa* (L.) C.F. Gaertn., UFP 28539; PESQUEIRA, Bezerra, M. F. A. 51, 29.I.2002, UFP 31705; IGARASSU, Cavalcanti L. H. 1999, dead leaves, UFP 2858; MIRANDIBA, Ferreira, I.N. et al 31, 28.VI.2008, on xique-xique, UFP 54364; RIO FORMOSO, Nossa Senhora do Ó Mangrove, Damasceno, G.S. 21, 26.IV.2007, on aerial litter of *Conocarpus erect*us L. UFP 46328.**Rio Grande do Norte State:** BAIA FORMOSA, Mata Estrela, Bezerra, A. C. C. 852, 08.V.2007, on dead wood, UFP 55933; Mata Estrela, Bezerra, A. C. C. 853, 08.V.2007, on dead leaf, UFP 55934.

Comments: To date, all studies show that this is the most common and abundant *Diachea* species in the Neotropics. However, this widely distributed cosmopolitan species has only been recorded once for Bahia (Torrend 1915; municipality not noted), twice for Piauí (Mobin & Cavalcanti 2000), and nine times for Pernambuco, without records for the other northeastern states. In the Northeast region it is seldom found in large numbers of specimens, but frequently reaches large fructifications, especially in Atlantic forest remnants. One specimen (UFP 28539) was collected in the municipality of Olinda-PE at the Chico Science mangrove, an unusual environment for myxomycetes; the sporangia, which developed on the bark of *Laguncularia racemosa* in moist chamber cultures, had very long stalks associated with a long cylindrical sporotheca (Fig. 2a); thus, this collection is referred to as *D. leucopodia* with some caution. Two specimens of *D. leucopodia* were collected by Mobin & Cavalcanti (2000) at the Sete Cidades National Park, associated with *Copernicia prunifera* (*Arecaceae*) in a savanna area. This is the first record of this species for Rio Grande do Norte state.

Diachea silvaepluvialis M. L. Farr, Contr. U. S. Natl. Herb. 37(6): 409. 1969. Figs. 3–5)

Sporangia gregarious, stipitate, sporotheca globose to subglobose, dark-brown, 400 µm diam., 800–1000 µm total height; stipe calcareous, dark orange or dark brown, tapering toward the apex, striate, lime crystals 5–15 µm diam.; columella more or less cylindrical, tapering upward, reaching nearly half the height of the sporotheca; peridium iridescent, usually persisting at the base, pale brown; capillitium lax, arising along the entire columella, forming a lax reticulum, with dark brown filaments 1–2 µm diam., and slightly paler free ends; hypothallus



Figures 1–3. 1. *Diachea bulbillosa*: A- sporocarps and columella; B- rhombohedron crystals of the stalk; C- capillitium; D spores. 2. *D. leucopodia*: A- sporocarps and columella; B- rhombohedron crystals of the stalk; C- capillitium; D- spore; E- sporocarp of the specimen collected in mangrove forest, with a very long stalk. 3. *D. silvaepluvialis*: A- sporocarps and columella; B- rhombohedron crystals of the stalk; C- capillitium; D- spore.

membranous, discoid, brownish, sometimes obsolete; spores dark brown in mass, dark purplish brown by transmitted light, sparsely to closely spinulose, sometimes densely warted, 10–14 µm diam.

Distribution in Brazil: Northeast (SE).

SELECTED EXSICCATES: **BRAZIL. Paraíba State**: AREIA, Mata do Pau Ferro Ecological Reserve, Boa Vista trail, Costa, A. A. A. 36A, 03.VI. 2005, on dead wood and dead leaf, UFP 41869. **Sergipe State:** AREIA BRANCA, Serra de Itabaiana National Park, Bezerra, M. F. A. 134, 13.lV.2002, dead leaf, UFP 34352. **Pernambuco State**: SÃO VICENTE FERRER, Mata do Estado, Ferreira, I.N. et al 89, on dead leaf, UFP 48487.

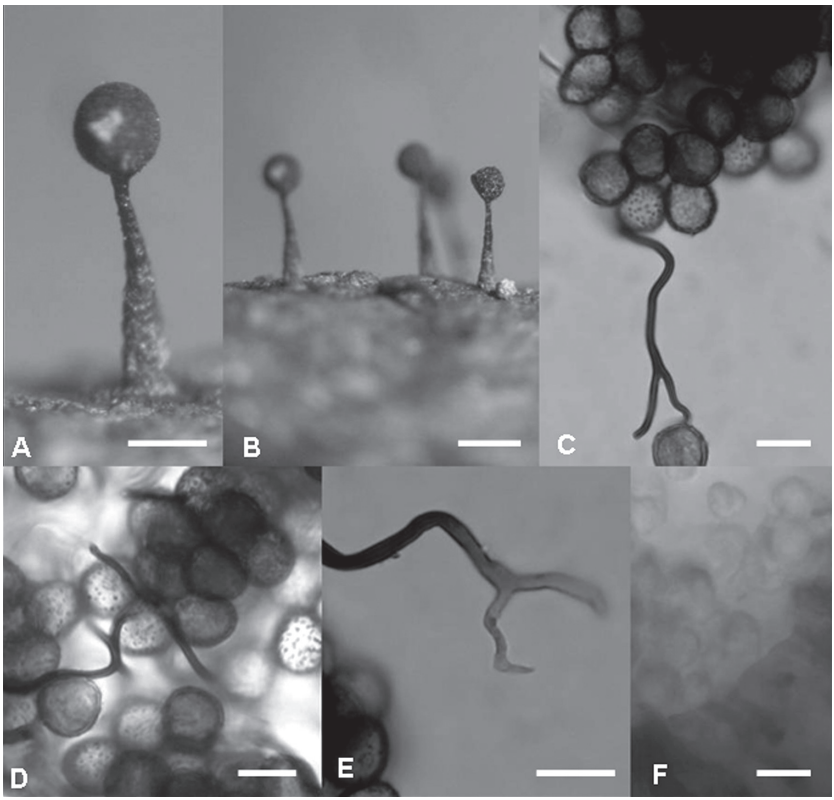


Figure 4. *Diachea silvaepluvialis* (UFP 41869): A and B - sporocarps; C and D - capillitium and spores; E – capillitium; F- rhombohedron crystals of the stalk.
Scale bars: A = 250 µm. B = 500 µm. C-F = 10 µm.

Comments: This species has been collected in three reserves of Atlantic forest, in the states of Paraíba, Pernambuco, and Sergipe, at altitudes above 400 m. However, further fieldwork may prove that it is widespread in the northeastern part of the country. This is the first record of *D. silvaepluvialis* for Paraíba and Pernambuco states.

Conclusions

The available data show that 25% of the known *Diachea* species are represented in Northeast Brazil, occurring in savanna, ombrophilous forest, stationary semideciduous lowland forest, riverine forest and in the submontane forests regionally known as "brejos de altitude".

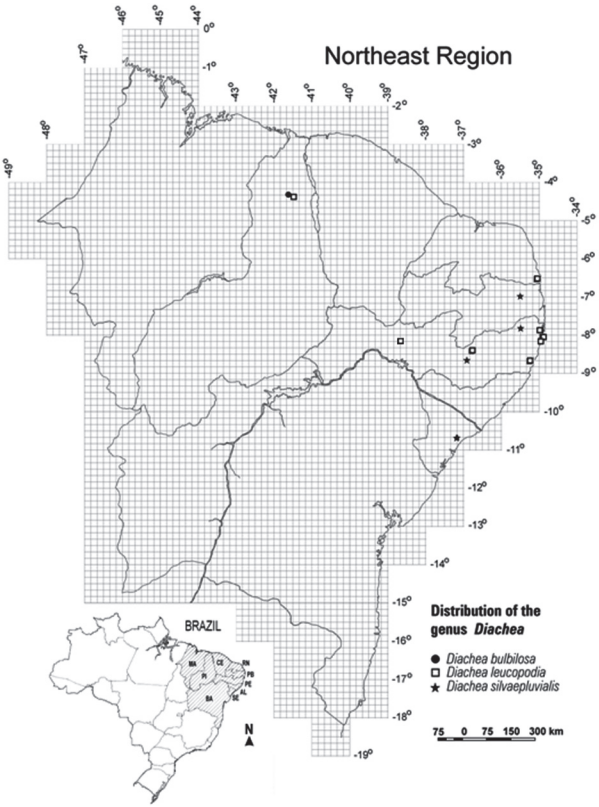


Figure 5. Distribution of *Diachea bulbillosa*, *D. leucopodia*, and *D. silvaepluvialis* in Northeast Brazil.

Sporocarps of the three species may be found during different seasons and in different environments, including mangroves, as corticolous, foliicolous, or lignicolous, and the largest populations were found in the Atlantic forest. Until now, *D. silvaepluvialis* has been recorded exclusively in Atlantic Forest remnants, covered with open ombrophilous or riverine forest, 400–600 m above sea level.

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Literature cited

Araujo FS, Sampaio EVSB, Figueiredo MA, Rodal MJN, Fernandes AG. 1998. Composição florística da vegetação de carrasco. Revista Brasileira de Botânica 21(2): 105–116.

Bezerra MFA, Bezerra ACC, Nunes AT, Lado C, Cavalcanti LH. 2008. Mixobiota do Parque Nacional Serra de Itabaiana, SE, Brasil: *Physarales.* Acta Botanica Brasílica 22(4): 1044–1056.

Farr ML. 1974. Some new *Myxomycetes* records for the Neotropics and some taxonomic problems in the *Myxomycetes*. Proceedings of the Iowa Academy of Science 81: 37–40.

Farr ML. 1976. *Myxomycetes.* pp. 1–305, in CT Rogerson (org.), Flora Neotropica Monograph 16. New York, New York Botanical Garden.

Fiore-Donno AM, Berney C, Pawlowsky J, Baldauf SL. 2005. Higher order phylogeny of plasmodial slime-molds (*Myxogastria*) based on elongation factor 1-A and small subunit rRNA gene sequence. Journal of Eukaryotic Microbioly 52(3): 201–210.

Fries EM. 1825. Systema orbis vegetabilis. Primas lineas novae constructionis. Pars I. Plantae homonemeae. Lund.

Fundação Instituto Brasileiro de Geografia e Estatística – IBGE. 1985. Atlas Nacional do Brasil (Região Nordeste), Rio de Janeiro.

Gaither TW, Keller H. 2004. Taxonomic comparison of *Diachea subsessilis* and *D. deviata* (*Myxomycetes, Didymiaceae*) using scanning electron microscopy. Systematics and Geography of Plants 74(1): 217–230.

Hagelstein R. 1944. The *Mycetozoa* of North America. Mineola, New York.

Hernández-Crespo JC, Lado C. 2005. An on-line nomenclatural information system of Eumycetozoa. Retrieved November 26, 2006, from http://www.nomen.eumycetozoa.com.

Kalyanasundaram I, Mubarak Ali N. 1989. Taxonomic note on the myxomycete genus *Diachea*. Mycological Research 93(2): 235–237.

Keller H, Skrabal M, Eliasson UH, Gaither TW. 2004. Tree canopy biodiversity in the Great Smoky Mountains National Park: ecological and developmental observations of a new *myxomycete* species of *Diachea*. Mycologia 96(3): 537–547.

Lado C. 2001. Nomenmyx – A nomenclatural Taxabase of *Myxomycetes.* Cuadernos de Trabajo de Flora Micológica Ibérica 16. Madrid, Real Jardín Botánico.

Lado C, Basanta DW. 2008. A review of Neotropical *Myxomycetes* (1828–2008). Anales del Jardín Botánico de Madrid 65(2): 211–254.

Lemos JR, Rodal MJN. 2002. Fitossociologia do componente lenhoso de um trecho da vegetação de caatinga no Parque Nacional Serra da Capivara, Piauí, Brasil. Acta Botanica Brasílica 16(1): 23–42.

Lister A. 1925. A Monograph of the *Mycetozoa*. London, British Museum Natural History.

Martin GW, Alexopoulos CJ. 1969. The *Myxomycetes*. Iowa City, University of Iowa Press.

Martin GW, Alexopoulos CJ, Farr ML. 1983. The genera of *Myxomycetes*. Iowa City, University of Iowa Press.

Mobin M, Cavalcanti LH. 1999. *Physarales* (*Myxomycetes*) do Parque Nacional de Sete Cidades, Piauí, Brasil. Hoehnea 26(1): 1–14.

Mobin M, Cavalcanti LH. 2000. *Myxomycetes* em Carnaúba (*Copernicea prunifera*, *Arecaceae*). Acta Botanica Brasílica 14(1): 71–75.

Putzke J. 1996. *Myxomycetes* no Brasil. Cadernos de Pesquisa, Série Botânica 8: 1–133.

Sampaio EVSB. 1995. Overview of the Brazilian Caatinga. pp. 35–63, in SH Bullock, HA Mooney, E Medina (eds), Seasonal dry tropical forests. Cambridge University Press, London.

Torrend C. 1915. *Myxomycetes* du Brésil, connus jusqu'ici. Broteria 13: 72–88.

Torrend C. 1916. Os *Myxomycetes* dos arredores da Bahia. pp. 484–492, in L Anon (ed.), Anais do 5º Congresso Brasileiro de Geografia. Salvador, Sociedade Brasileira de Geografia.